

CLAIMS

What is claimed is:

1. A method of forming a light emitting device, said method comprising:
 - 5 forming at least one of Fresnel lens and holographic diffuser on at least one surface of a semiconductor light emitter to affect light emitted by said semiconductor light emitter.
 2. The method of claim 1 wherein said semiconductor light emitter has at least one light extraction surface from where light is intended to be extracted, and wherein said
10 forming is done on at least one extraction surface of said semiconductor light emitter.
 3. The method of claim 1 wherein said forming comprises pressing a stamping block against at least one surface of said semiconductor light emitter.
 4. The method of claim 1 wherein said forming is executed concurrently with a wafer-bonding process, said wafer-bonding process comprising:
 - 15 removing a first substrate of said semiconductor light emitter; and
 - bonding a second substrate to said semiconductor light emitter.
 5. The method of claim 1 wherein said forming comprises at least one method selected from etching, milling, ablation, machining, scribing, electron discharge machining, and stamping.
 - 20 6. The method of claim 1 further comprising:
 - beveling one or more sides of said semiconductor light emitter.
 7. The method of claim 1 wherein said semiconductor light emitter has a light emitting layer, said method further comprising:
 - confining light emission to a preselected section of said light emitting layer.

8. The method of claim 7 wherein said confining comprises at least one method selected from applying the Holonyak process, using selective area growth, using selective area bonding, using diffusion, and using ion implantation.
9. The method of claim 1 further comprising:
- 5 coating one or more surfaces of said semiconductor light emitter with a reflective material.
10. The method of claim 1 further comprising:
- coating said Fresnel lens or said holographic diffuser with a reflective material.
11. The method of claim 2 further comprising:
- 10 forming an optical element on the surface opposite of said extraction surface.
12. A light emitting device comprising:
- a semiconductor light emitter; and
- a first optical element forming at least one surface of said semiconductor light emitter, said first optical element comprising one of Fresnel lens and holographic
- 15 diffuser.
13. The device of claim 12 further comprising:
- a reflective material coating at least one surface of said device.
14. The device of claim 12 wherein a light emitting layer of said semiconductor light emitter is made to emit photons primarily toward a preselected section of said first optical
- 20 element.
15. The device of claim 12 wherein at least one surface of light emitting device is beveled.
16. The device of claim 12 wherein said semiconductor light emitter is a confined-emission spot light emitting diode.

17. The device of claim 12 wherein said semiconductor light emitter and said first optical element comprise $(\text{Al}_x\text{Ga}_{1-x})_y\text{In}_{1-y}\text{P}$ where $0 \leq x \leq 1$ and $0 \leq y \leq 1$.
18. The device of claim 12 wherein said light-emitting diode comprises a III-nitride semiconductor alloy and said first optical element comprises one of silicon carbide and sapphire.
19. The device of claim 12 wherein said semiconductor light emitter and said first optical element comprise aluminum gallium arsenide semiconductor alloy.
20. The device of claim 12, wherein said semiconductor light emitter has a flip-chip configuration.
21. The device of claim 12, wherein said semiconductor light emitter has a configuration in which a light emitting layer of said semiconductor light emitter is substantially perpendicular to said Fresnel lens.
22. The device of claim 12, wherein the radiation pattern of said device is controlled by the ratio of the focal length of said first optical element to the distance between said first optical element and a light-emitting layer of said semiconductor light emitter.
23. The device of claim 12, wherein said first optical element is designed to achieve one of light focusing, light collimating, and light diverging.
24. The device of claim 12 wherein said first optical element is designed to direct light in a preselected direction.
25. The device of claim 12 further comprising:
a second optical element on a surface of said semiconductor light emitter opposite the surface having said first optical element.
26. The device of claim 25 wherein at least one of said first Fresnel lens and said second Fresnel lens is designed to focus light.
27. A method of forming a light emitting device, said method comprising:

Stamping at least one optical element on at least one surface of a semiconductor light emitter to affect the light emitted by said semiconductor light emitter.

28. The method of claim 27 further comprising:

coating a surface of said light emitting device with a reflective layer.

5 29. The method of claim 27 wherein said stamping is done on at least one of a semiconductor layer and a substrate layer of said semiconductor light emitter.

30. The method of claim 29 wherein said semiconductor layer comprises a transparent aluminum-bearing compound.

10 31. The method of claim 27, wherein said pressing is executed at an elevated temperature, said elevated temperature being higher than room temperature.

32. The method of claim 31, further comprising lowering said elevated temperature to facilitate the separation of said stamping block from said semiconductor light emitter after said pressing.

15 33. The method of claim 32, wherein said elevated temperature is higher than the ductile transition temperature of the material constituting said at least one surface on which said Fresnel lens is formed.

34. A light emitting device comprising:

a semiconductor light emitter; and

20 at least one optical element stamped on at least one surface of semiconductor light emitter, wherein said optical element is a first optical element.

35. The device of claim 34 wherein a light emitting layer of said semiconductor light emitter is made to emit photons primarily toward a preselected section of said first optical element.

25 36. The device of claim 34 wherein said light-emitting and said first optical element comprise $(\text{Al}_x\text{Ga}_{1-x})_y\text{In}_{1-y}\text{P}$ where $0 \leq x \leq 1$ and $0 \leq y \leq 1$.

37. The device of claim 34 wherein said semiconductor light emitter comprises a III-nitride semiconductor alloy and said first optical element comprises one of silicon carbide and sapphire.
38. The device of claim 34 wherein said semiconductor light emitter and said first
5 optical element comprise aluminum gallium arsenide semiconductor alloy.
39. The device of claim 34 wherein said light emitting diode has a flip-chip configuration.
40. The device of claim 34 wherein said light emitting diode has a configuration in
10 which the light emitting layer of said light emitting diode is substantially perpendicular to said Fresnel lens.
41. A light emitting diode array comprising a plurality of light emitting devices, a light emitting device comprising:
- a semiconductor light emitter; and
 - one of a Fresnel lens and a holographic diffuser formed on a surface of said
15 semiconductor light emitter.
42. A light emitting array comprising a plurality of light emitting devices, a light emitting device comprising:
- a semiconductor light emitter; and
 - an optical element stamped on a surface of said semiconductor light emitter.
- 20 43. A display device comprising at least one blue light emitting device, at least one green light emitting device, and at least one red light emitting device, wherein at least one of said blue light emitting device, green light emitting device, and red light emitting device comprises:
- a semiconductor light emitter; and

one of a Fresnel lens and a holographic diffuser formed on a surface of said semiconductor light emitter.

44. A display device comprising at least one blue light emitting device, at least one green light emitting device, and at least one red light emitting device, wherein at least one
5 of said blue light emitting device, green light emitting device, and red light emitting device comprises:

a semiconductor light emitter; and

one optical element stamped on a surface of said semiconductor light emitter.

45. A method for forming a light emitting device, said method comprising:
10 stamping an optical element in a material, said material being transparent to light emitted from said light emitting device; and
bonding said optical element to a semiconductor light emitter.